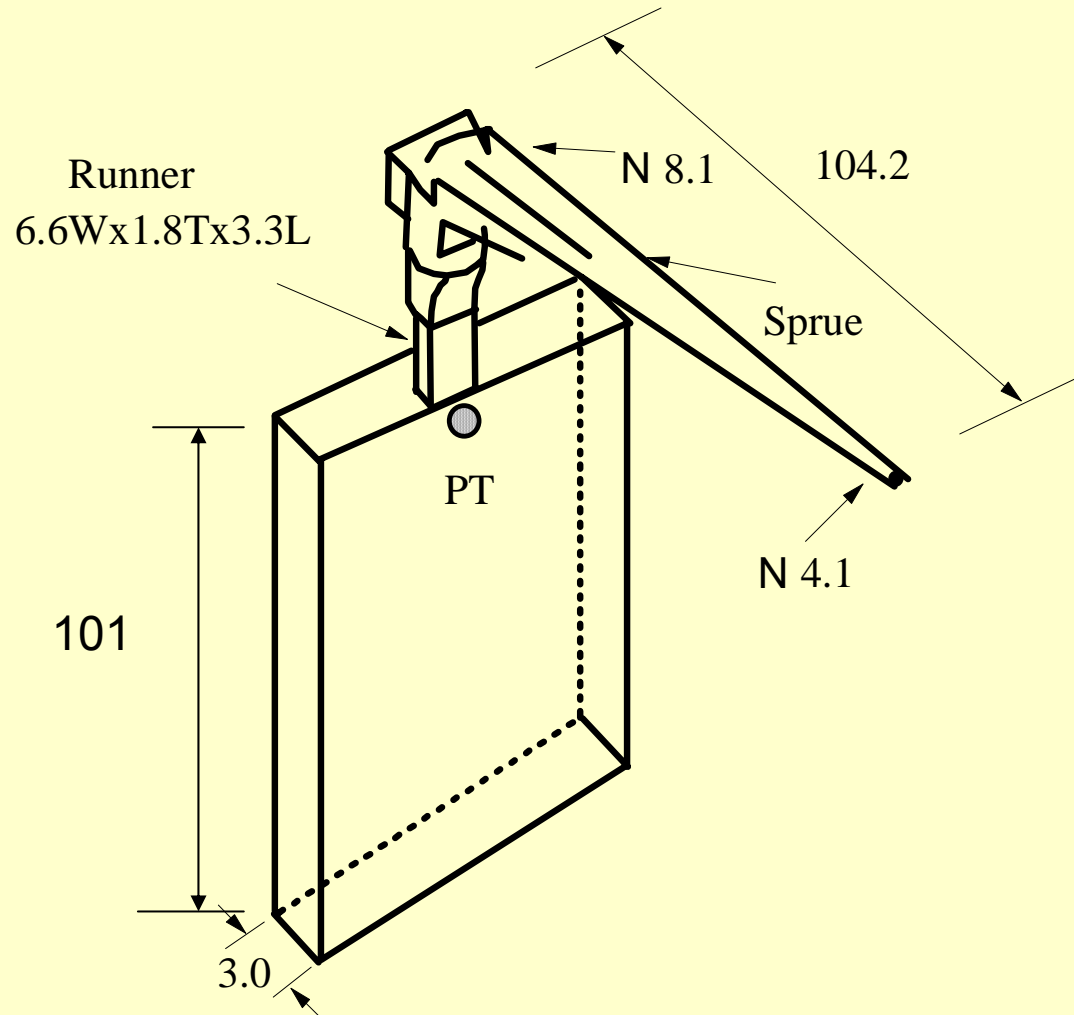
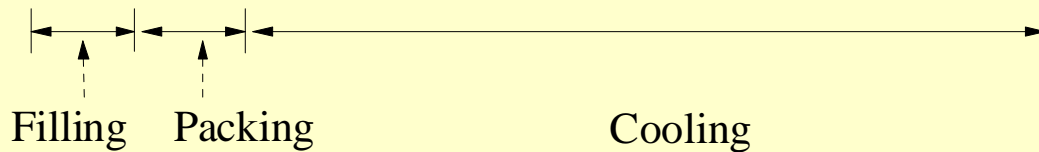
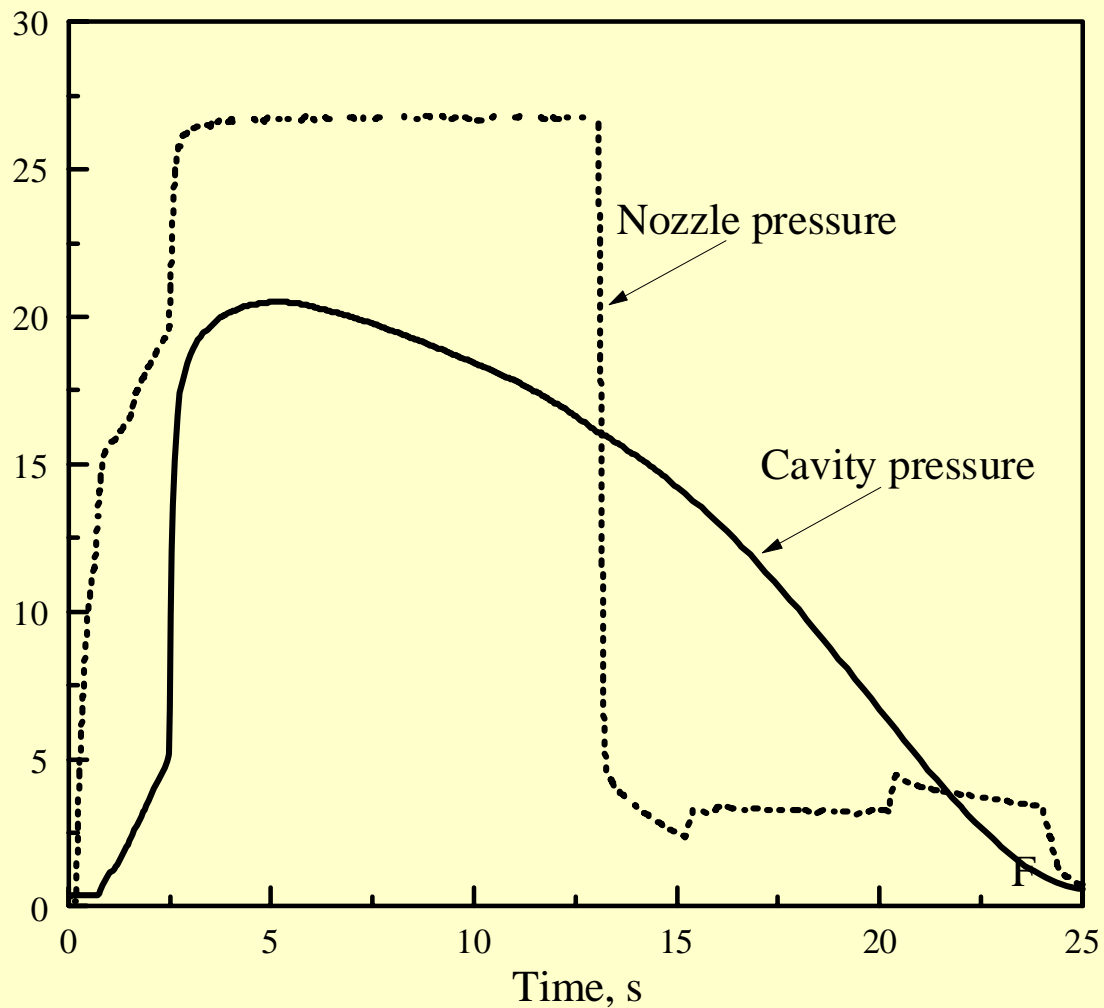


CAVITY DIMENSIONS



PRESSURE PROFILES



MODELS

$$\rho C_p \frac{\partial T}{\partial t} - \left[\frac{\partial}{\partial x} \left(k \frac{\partial T}{\partial x} \right) + \frac{\partial}{\partial y} \left(k \frac{\partial T}{\partial y} \right) + \frac{\partial}{\partial z} \left(k \frac{\partial T}{\partial z} \right) \right] + \rho C_p \left(u_x \frac{\partial T}{\partial x} + u_y \frac{\partial T}{\partial y} \right) = \eta \gamma^2$$

$$\frac{\partial}{\partial x} \left(S \frac{\partial p}{\partial x} \right) + \frac{\partial}{\partial y} \left(S \frac{\partial p}{\partial y} \right) = 0$$

$$S = \int_0^b \frac{z^2 dz}{\eta}$$

BOUNDARY CONDITIONS

- Cavity entry
($x = 0, 0 \leq y \leq g_w, 0 \leq z \leq g_h$)
- Cavity walls
- Mid-cavity gapwise plane
($y = 0$)

Dirichlet

- $T = T_e, p = p_o$

- $T = T_w$

- Neumann

$$\partial p / \partial n = 0$$

$$\partial T / \partial n = 0, \quad \partial p / \partial n = 0$$

$$p_o = \begin{cases} \alpha t, & t_{fill} \geq t \geq 0 \\ p_{ef} + (p_p - p_{ef})(1 - \exp(-t/\tau)), & t_{pack} \geq t \geq t_{fill} \end{cases}$$

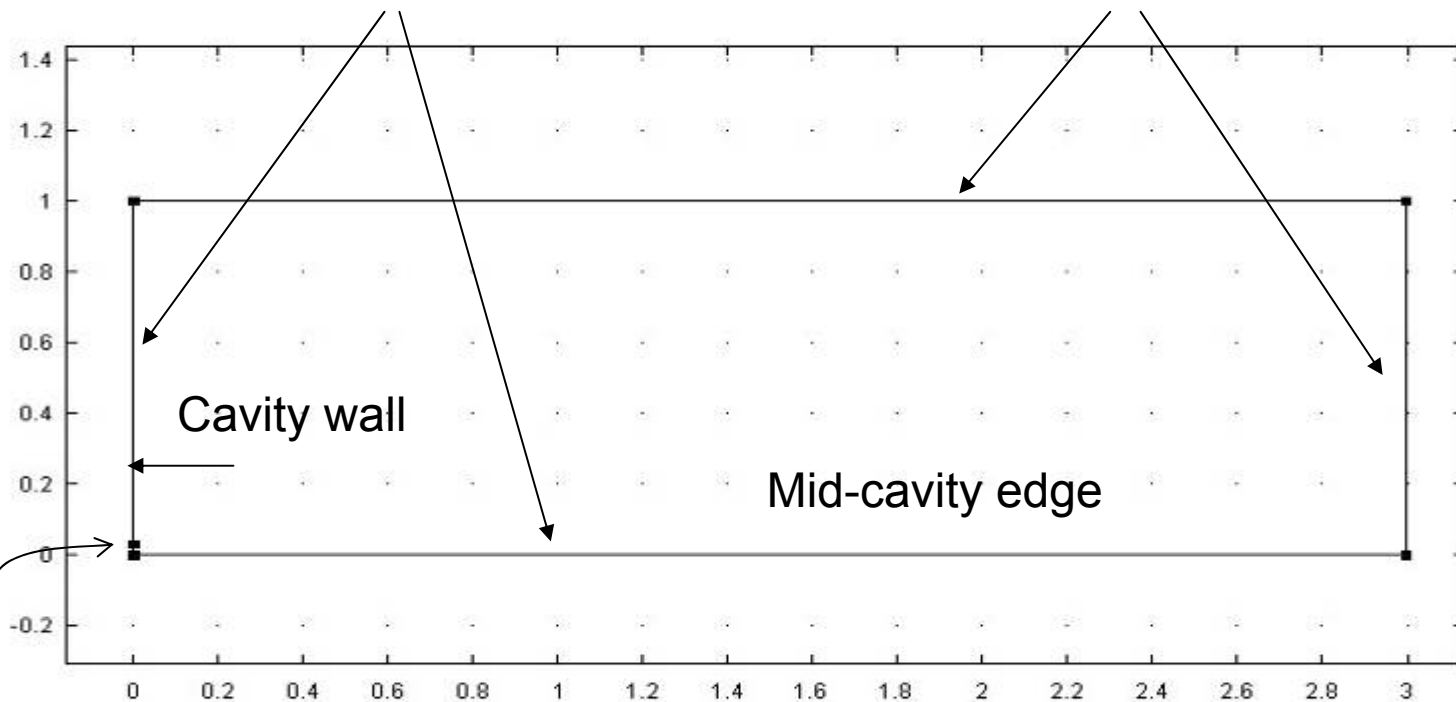
- $t_{fill} = 1 \text{ s}, t_{pack} = 2.5 \text{ s}$
- $\alpha = 5.19 \text{ MPa/s}, p_{ef} = 5.19 \text{ MPa}, p = 22.06 \text{ MPa}, \tau = 0.16 \text{ s}.$

INITIAL CONDITIONS $T = T_w, p = 0$

MIDCAVITY X-Y PLANE, GEOM 1

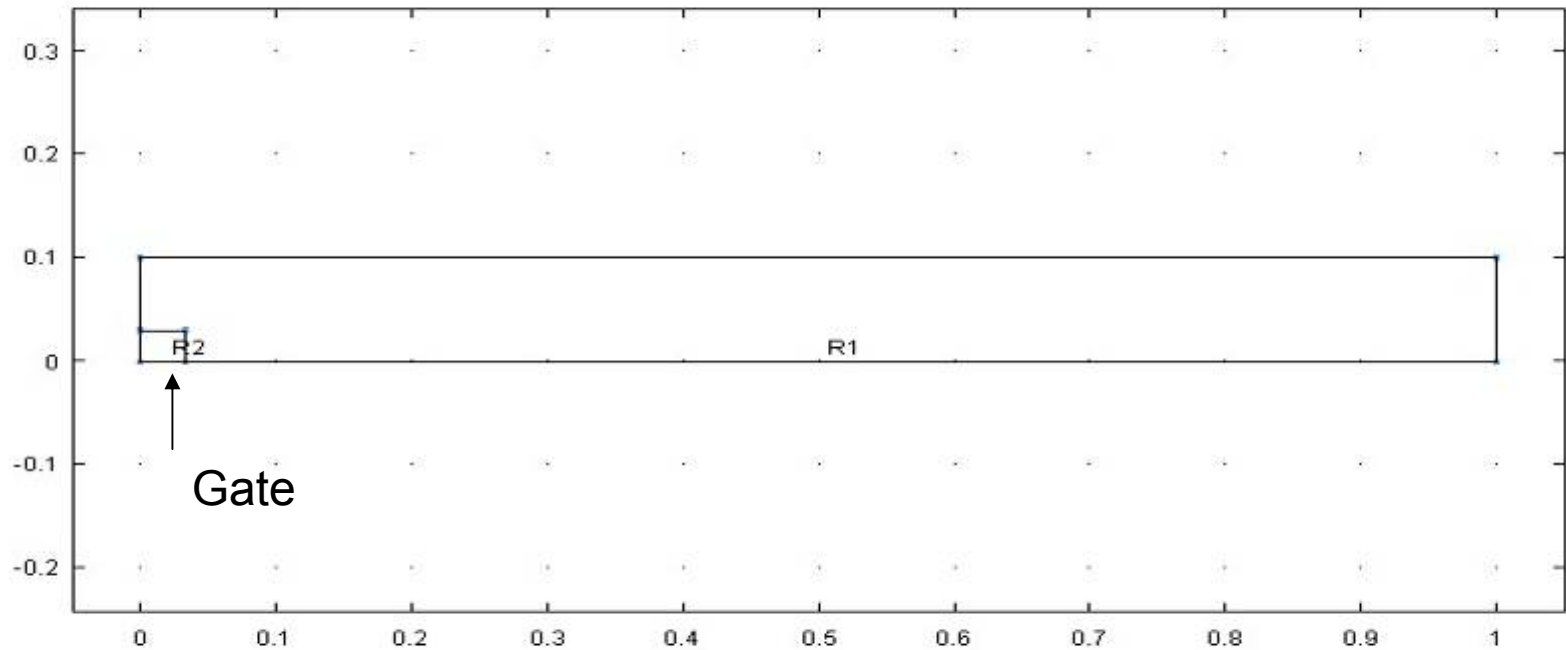
Neumann $\partial p / \partial n = 0$

Dirichlet, $p = p$, front flow

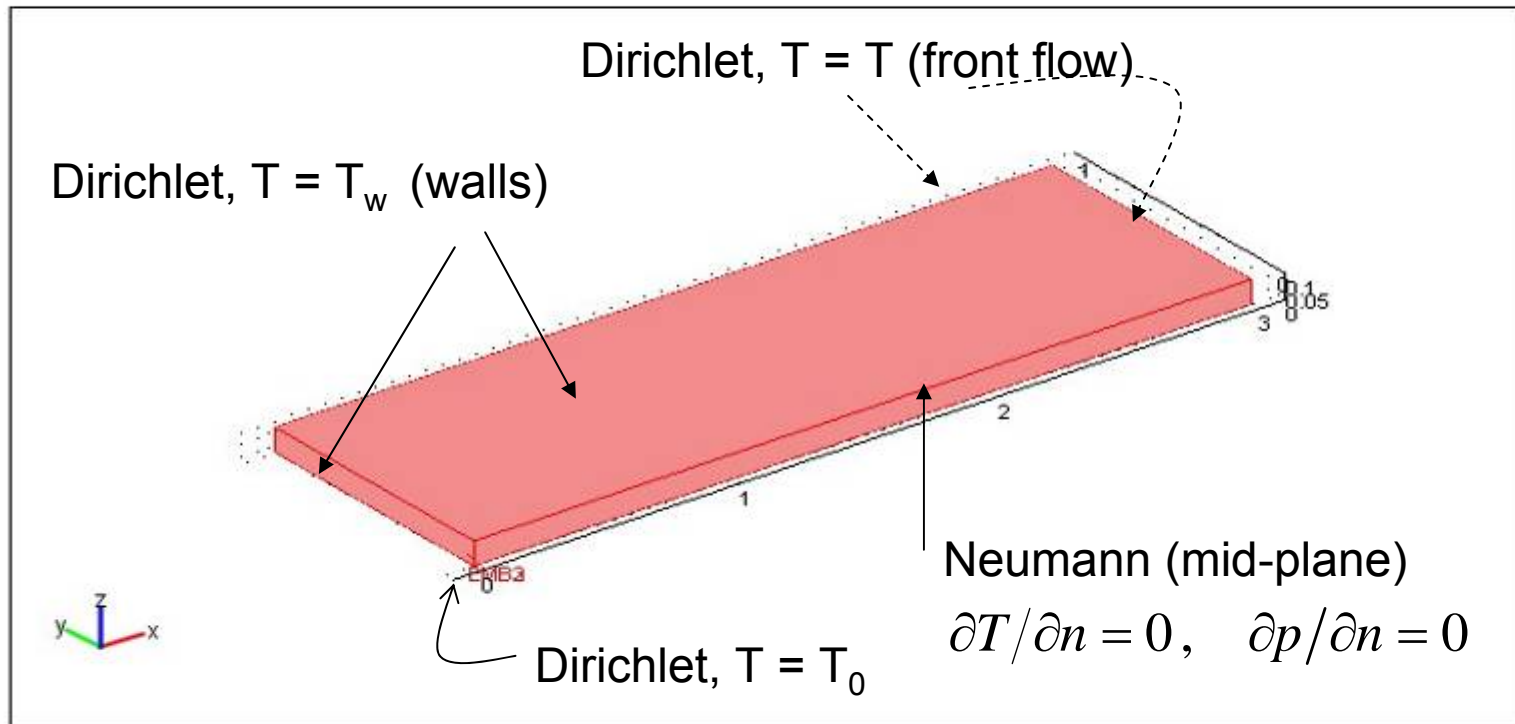


Dirichlet, $p = p_0$ (Gate)

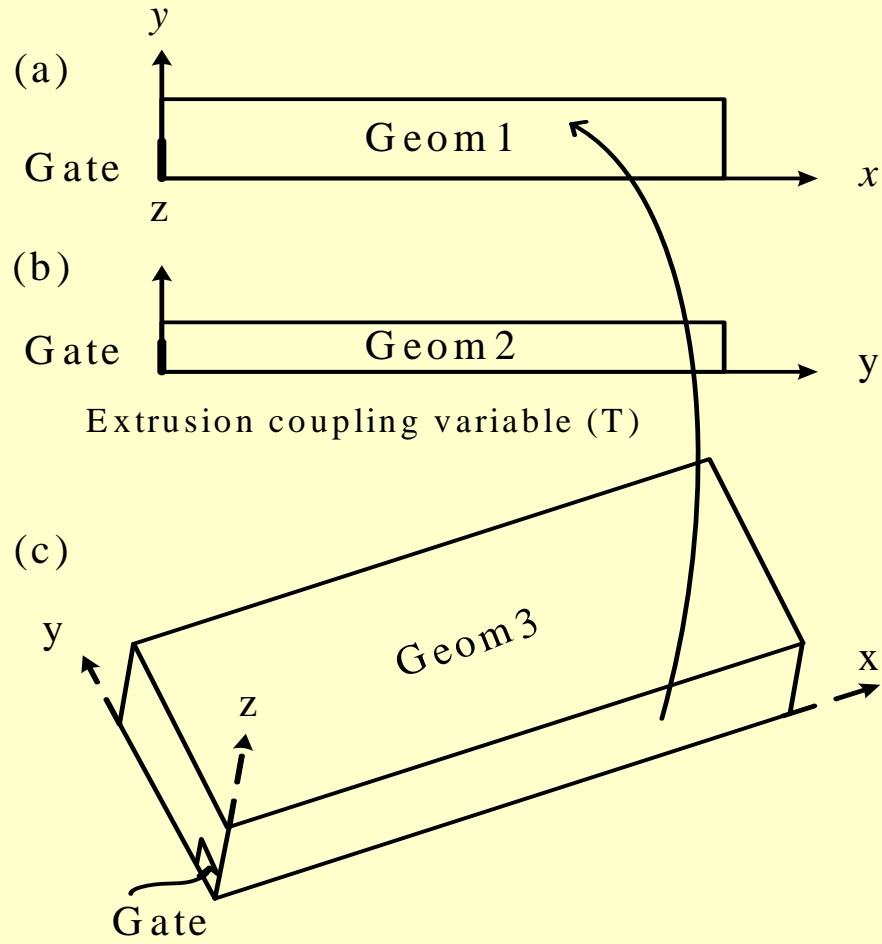
MIDCAVITY Y-Z PLANE, GEOM 3



MIDCAVITY, GEOM 3



GEOMETRY MODELING



PROPERTY MODELS

$$\eta = \eta_o \left[1 + \left(\frac{\eta_o}{\gamma \tau^*} \right)^{1-n} \right]^{-1}$$

$$\gamma = \sqrt{(\partial u_x / \partial z)^2 + (\partial u_y / \partial z)^2}$$

$$v = v_o \left[1 - C \log \left(1 + \frac{p}{B} \right) \right]$$

$$C_p = c_1 + c_2 \bar{T} + c_3 \tanh(c_4 \bar{T}),$$

$$k = \lambda_1 + \lambda_2 \bar{T} + \lambda_3 \tanh(\lambda_4 \bar{T})$$

$$S = \int_0^b \frac{z^2 dz}{\eta}$$

$$\eta_o = B \exp\left(\frac{T_b}{T}\right) \exp(\beta p)$$

$$v_o = \begin{cases} b_{1,l} + b_{2,l} \bar{T} & \text{if } T > T_t \\ b_{1,s} + b_{2,s} \bar{T} & \text{if } T < T_t \end{cases},$$

$$B(T) = \begin{cases} b_{3,l} \exp(-b_{4,l} \bar{T}) & \text{if } T > T_t \\ b_{3,s} \exp(-b_{4,s} \bar{T}) & \text{if } T < T_t \end{cases}$$

$$\bar{T} = T - c_5, \quad \bar{T} = T - \lambda_5$$

$$\bar{T} = T - b_5, \quad T_t(p) = b_5 + b_6 p$$

PDE COEFFICIENT FORM

$$d_a \frac{\partial u}{\partial t} - \nabla \cdot (c \nabla u + \alpha u - \gamma) + \beta \cdot \nabla u + au = f$$

$$u = \begin{bmatrix} p \\ T \end{bmatrix}, d_a = \begin{bmatrix} 0 \\ \rho C_p \end{bmatrix}, c = \begin{bmatrix} \hat{S} \\ \hat{k} \end{bmatrix}$$

$$\beta = \begin{bmatrix} 0 & 0 \\ \rho C_p u_x / scale_x^2 & \rho C_p u_y / scale_y^2 & 0 \end{bmatrix}, f = \begin{bmatrix} 0 \\ \cdot \\ \eta \gamma^2 \end{bmatrix}$$

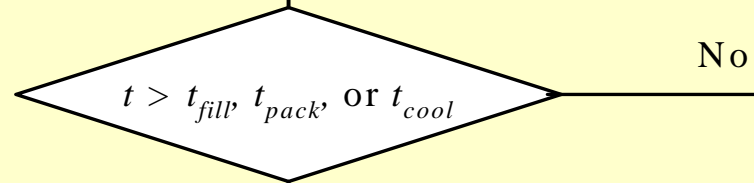
$$hu = r, n \cdot (c \nabla u + \alpha u - \gamma) + qu = g - h^T \mu$$

Define 2D (**Geom1**) and 3D (**Geom3**) geometries,
physical data and operation conditions

Set constants, application mode 1 (PDE coefficient
form), subdomain expressions, global expressions,
and coupling variables for **Geom1** and **Geom3**.

Increment time: $t = t + dt$,
and melt growth (for the filling stage): $L = L + dL$

Find solutions for the temperature and pressure
equations at time t and save extended mesh structure
(xmesh) for the next iteration.

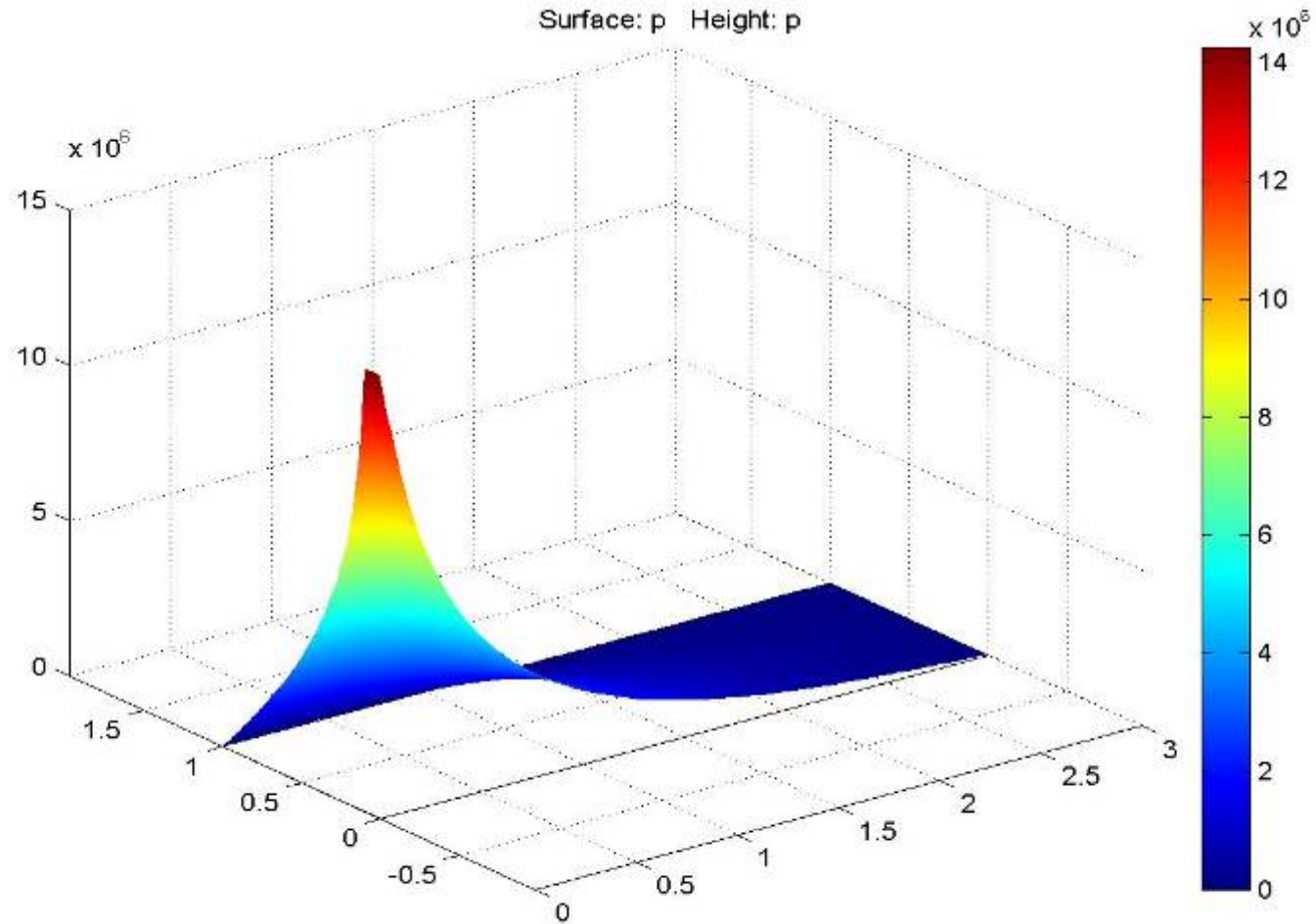


Yes

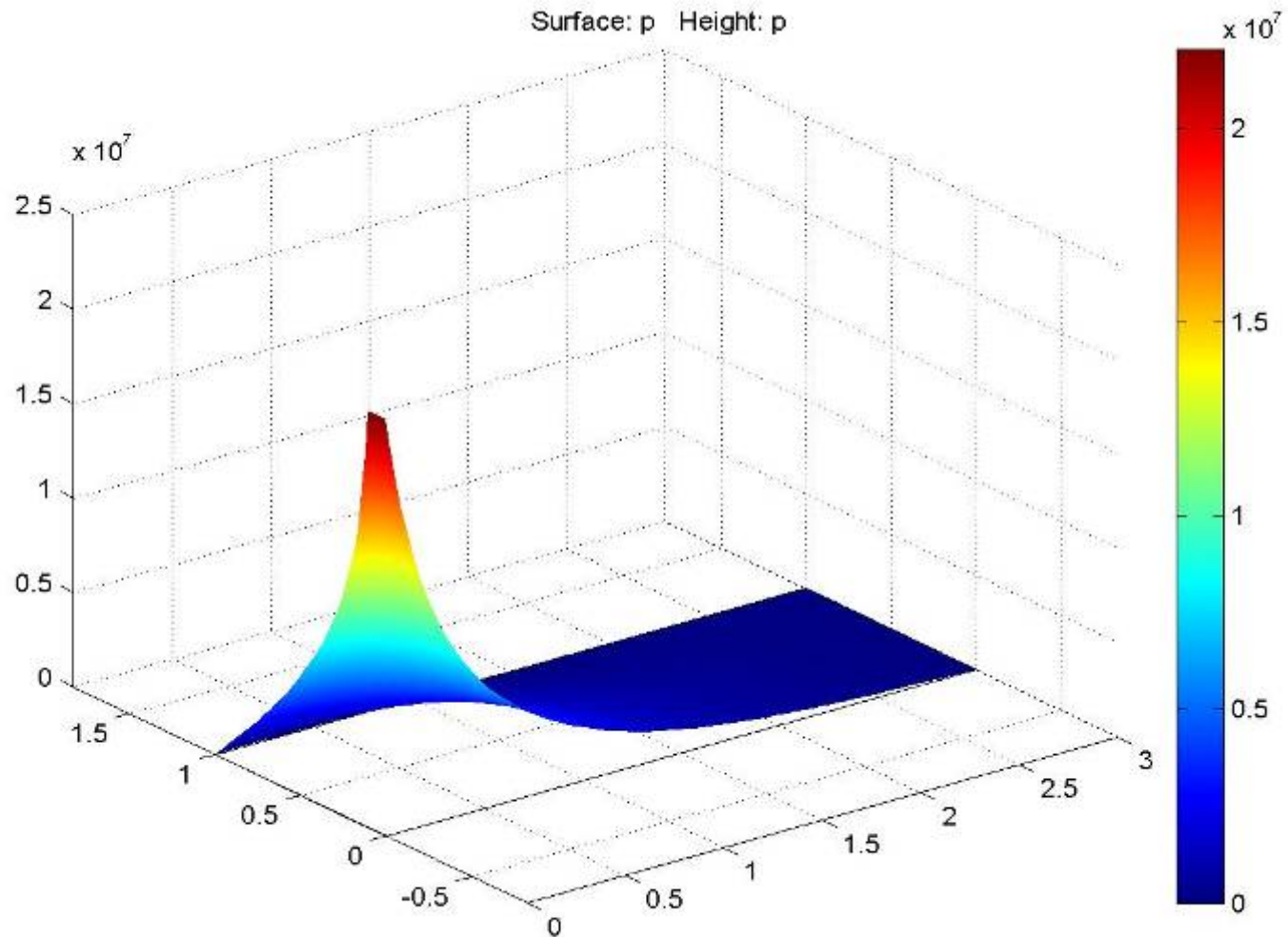
Stop

PROGRAM
FLOWCHART

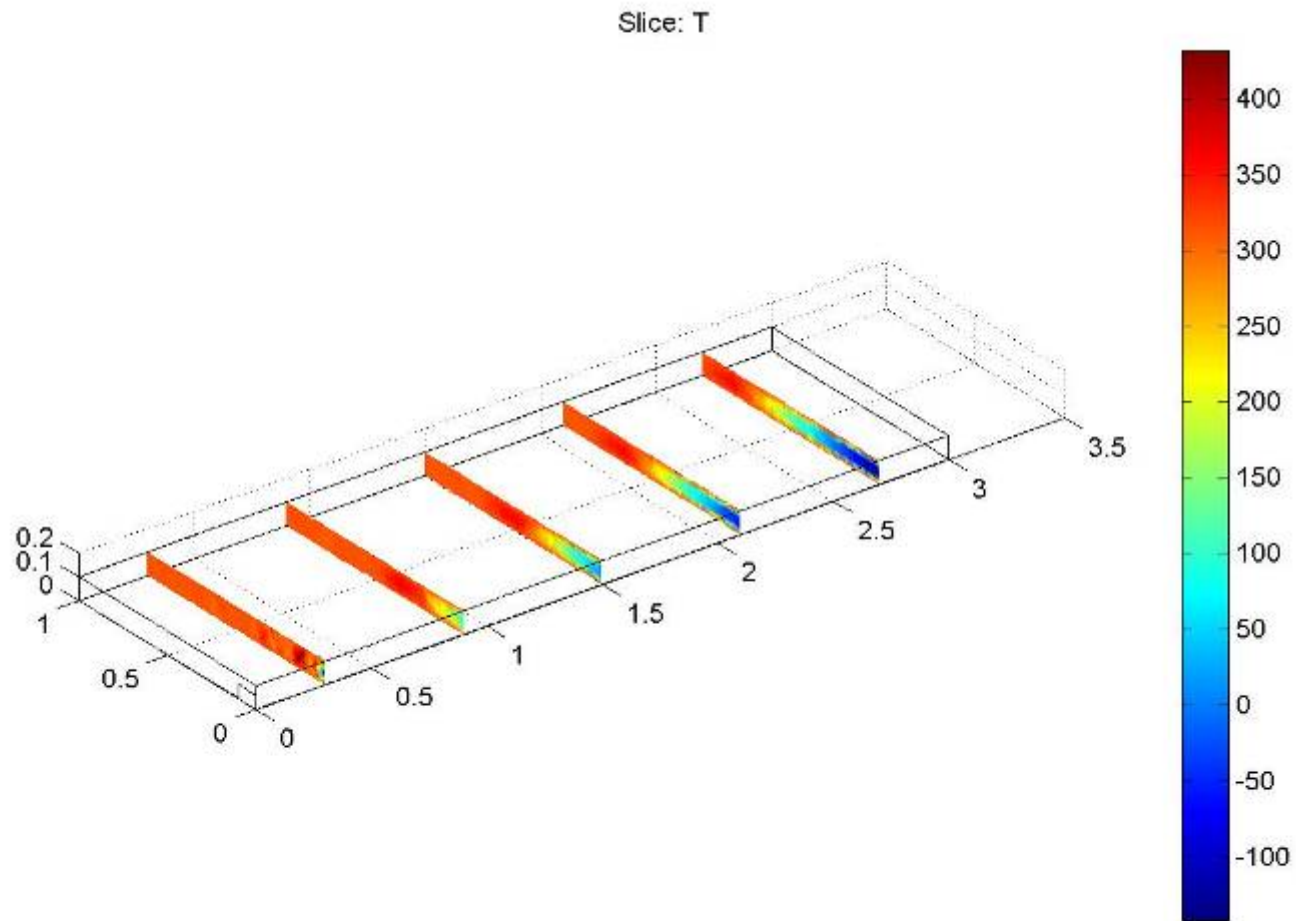
FILLING PRESSURE DISTRIBUTION



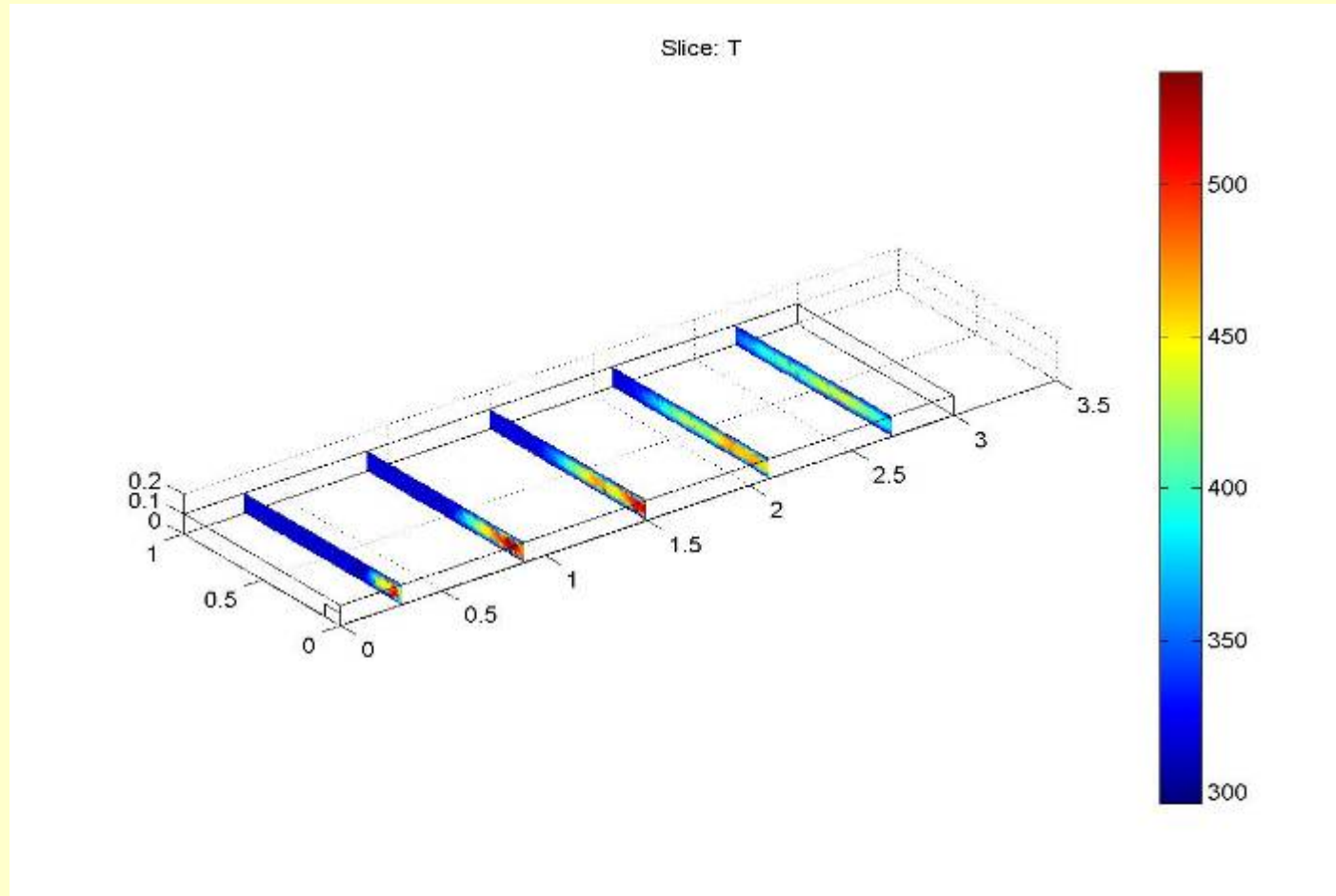
PACKING PRESSURE



END OF FILLING TEMPERATURES

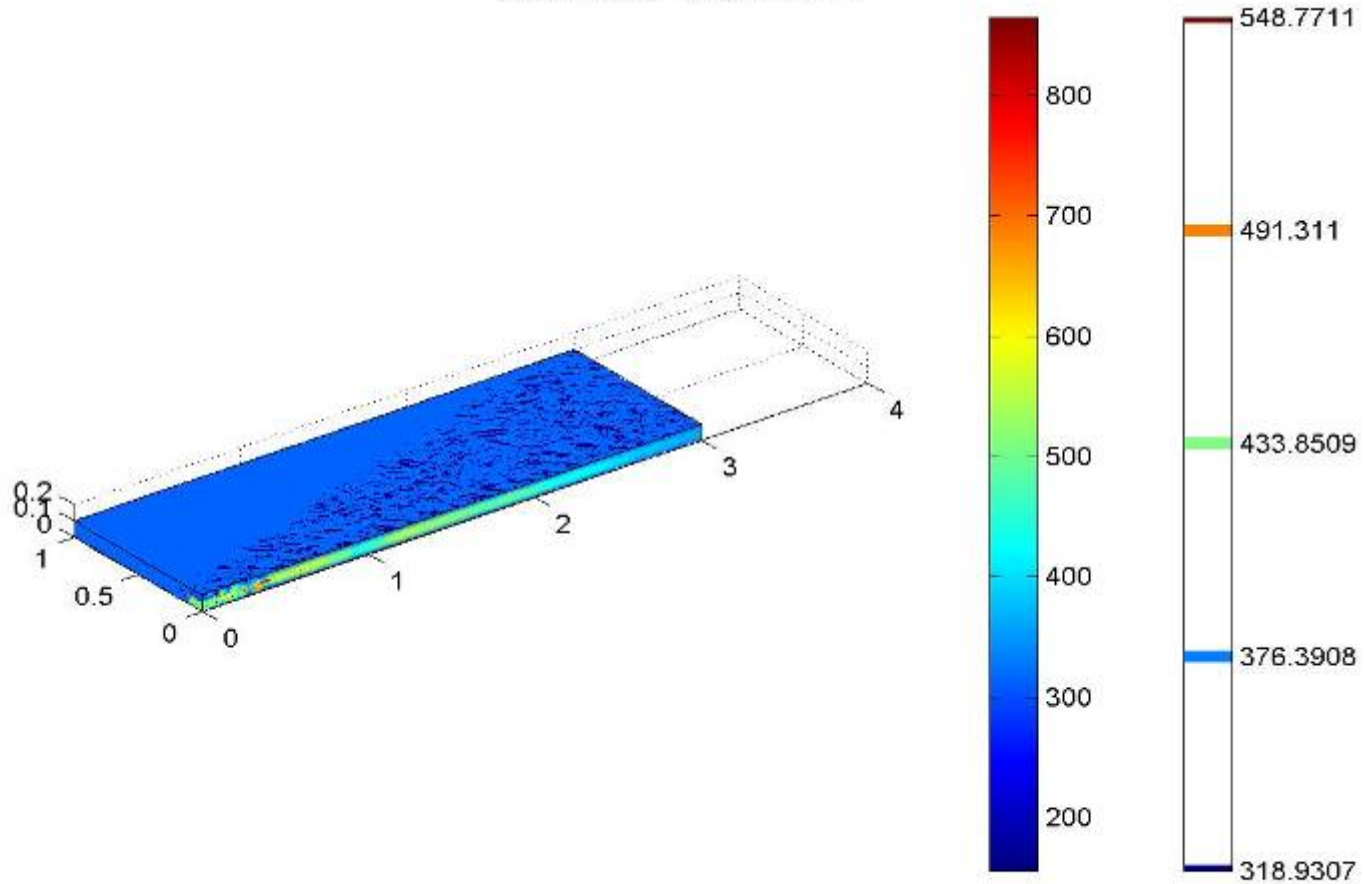


END OF PACKING TEMP DIST.



END OF PACKING TEMPERATURES

Isosurface: T Subdomain: T



CONCLUSIONS

- ❖ This preliminary work has presented an application for determining pressure and temperature distributions in a rectangular cavity.

- ❖ Future work:
 - Use of extrusion coupling variables for pressure and temperature between 2D and 3D geometries, and the streamline upwind technique to stabilize the results.
 - Improvement in the models by using a time varying model and a 3D geometry for the cavity pressure.
 - Inclusion in the results of process variables such as the melt flow front and interface positions during the filling stage.
 - Model validation.

- QUESTIONS